Interim Report I-A2313-2

PEOPLE, ORGANIZATIONS, AND COMMUNICATIONS

An Operations Research Study of Army Communications

EXPERIMENT COMMAD

A Pilot Study on
The Relation of Communication Media to Staff Decision Making

Arnold E. Horowitz
Stephen D. Benson
Edward P. Buckley

April 1961

Prepared for

Army Communication Systems Division
Office of the Chief Signal Officer
Headquarters Department of the Army

Under

Contract DA-36-039-SC78332

THE FRANKLIN INSTITUTE
LABORATORIES FOR RESEARCH AND DEVELOPMENT
PHILADELPHIA PENNSYLVANIA

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FOREWORD

The investigation described in this report was performed under Department of the Army Contract DA-36-039-SC78332 and was under the direction of Mr. Benedict R. Jacobellis and Mr. Robert L. Timoney, successively, the Contracting Officer's Technical Representative.

The experiment was conducted under the supervision of Mr. Ezra S. Krendel, Manager of the Engineering Psychology Laboratory of The Franklin Institute, with Mr. Joel N. Bloom as Project Leader.

The authors wish to express their appreciation to the faculty and students of the Officer's Department of the U.S. Army Signal School for their cooperation, interest, and patience in carrying out this experiment. Especial thanks are due Colonel Edward N. Jenkins, Major George F. Clare, Major Robert N. Goldrick, Major Walter G. James, and Captain Thomas J. McQuade, who gave us so much of their time and facilities.

We would also like to acknowledge the invaluable technical assistance of Mr. Alexander M. Sutter, Miss Margaret M. Scullion, and Miss Ann M. Large, all of The Franklin Institute staff.

SUMMARY

This report, one of a series under the Franklin Institute Operations Research Study of Army Communications, deals with a pilot experiment designed to test the utility of simulated situations for the study of the effects of communications media on the effectiveness of staff functioning. Four different communications media (telephone, two types of simulated electrical, and face-to-face communications) were studied. The criterion measure of staff functioning effectiveness was a rated adequacy score of the goodness of solution to a standard Signal Corps Practical Exercise. Serving as subjects of the pilot experiment were officers completing the Signal Officers' Career Course at the U. S. Army Signal School. The practical exercise was one normally given as part of the course of instruction.

The experiment met its objective by demonstrating that simulated situations in military environments can be effectively employed for studying communications systems. The physical facilities, administrative and logistic problems were amenable to satisfactory control. The relevant variables were determined and also found to be capable of manipulation.

For the problem employed, no significant differences on the criterion measure were found between media. Although not conclusive (since samples were necessarily small and but one problem utilized), these results give rise to a number of highly significant questions relating to the nature of information feedback, utility of increased bandwidth, and the value of information storage arising from the existence of hard copy. These questions are treated in some detail and their implications for future research discussed.

Finally, based upon these findings, a program is outlined which is designed to provide definitive answers to the important question of the effects of communications media upon the effectiveness of staff functioning.

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BACKGROUND AND INTRODUCTION

The work reported in this paper is part of an Operations Research study of Army communications being conducted by The Franklin Institute under the sponsorship of the Army Communication Systems Division, Office of the Chief Signal Officer, Headquarters Department of the Army.

The basic objective of the program has been set forth in the contract guidelines as follows:

> "....The general objective of the study is to develop guidance in techniques of conveying information from its point of origin as human thought through its dissemination to the points of action. Accordingly, a comprehensive study of human factors involved in the generation of information; and the inter-relationship among humans, communications and organizational concepts concerned with the overall problem of collection and dissemination of information within a Headquarters is required. Primary emphasis is to be placed upon basic factors involved in the communication of intelligence between humans...."

The primary effort under this program has been directed toward the actual measurement of the effectiveness of organizational and human communication system elements in military communication networks in terms of a trade-off between the control of error and the delay involved in such error control. The measurement program has, in general, been concentrated upon data collection in a number of large operating headquarters so as to obtain a truly representative picture of the major army staff communication practices.

In certain respects, however, data from operating headquarters is inadequate to establish the nature of certain required relationships. This is particularly true in the case of the following specific questions raised by the contract guidelines:

> "....determine if services offered or proposed satisfy the communications needs. Example — is greater use of spoken communications desirable and practical (disregard technical problems)....?"
>
> "....determine the contribution of electrically transmitted messages to reduction of lead time, timely decision making, and effective staff coordination."

Certain aspects of these questions cannot be answered without experimental manipulations which are, of course, impossible in large units with important missions. Although the controlled nature of an experiment has, of necessity, a certain lack of realism, a departure from existing realism provides the experimenter with certain advantages. Chief among these is the ability to deliberately manipulate relevant variables while controlling others which otherwise might obscure pertinent relationships. For example, it is possible to study written vs. spoken communication systems allowing each approximately the same time lags. Then, too, experimentation provides for control of procedural variables which tend to differ from headquarters to headquarters by a surprising degree. Control of such variables tends to yield experimental results of greater generality. In view of other project objectives, only a highly preliminary effort could be made in the direction of an experimental program. A small scale experiment, testing the intrinsic effects of different modes of communication on staff operations with time lag differences eliminated, seemed feasible within the limits of our capabilities. Confining the experiment to a school setting which could provide (1) a suitable problem, (2) a population of appropriate subjects, and, as part of the curriculum, (3) simulation of normal staff work, seemed the most efficient approach. The school chosen was the Officers' Department of the U.S. Army Signal School at Fort Monmouth, New Jersey.

During most of the course of study of Signal Plans and Operations in both the Signal Officers Career Course (nine months) and the Associate Signal Officers Career Course (14 weeks) classes are divided into committees of four to six men. Practical Exercises (PE) are solved by these groups

in committee discussion. Toward the end of the course, however, the students are given a one day Practical Exercise (PE), "The Infantry Division in Retrograde Movement", during which one member of each group is chosen as Division Signal Officer. The other members of the group are assigned to the other positions in a divisional signal staff. They attack the problem in a manner similar to that of such a staff in the field. Each officer (Assistant Division Signal Officer, Wire, Radio, and Radio Relay) is responsible for producing a solution to a particular aspect of the overall problem and of coordinating his solution with other members of the simulated staff.

This practical exercise has many of the features required for a preliminary experiment. (1) There was a problem to be handled by staff action. (2) The personnel had enough knowledge of the subject matter, either by experience or through their recent schooling, to make their approach to the problem reasonably realistic. (3) Staff action was simulated, thereby enabling us to impose structuring on the communication process, thus making experimental comparisons between conditions possible. (4) The situation provided for the establishment of essentially homogeneous groups. (5) The structuring we proposed not only did not interfere with the teaching mission, but may have furthered it. Under ordinary conditions, the groups remain around their tables when acting as a staff, and the admonition of the instructors for division of labor and coordination has a tendency to break down under the habit of free face-to-face discussion developed previously in the course. Our proposed separation of the groups, allowing communication only by the assigned means of either telephone or simulated electrical communication, forced adherence to more usual staff-like functioning. We were, however, confronted by a serious problem, particularly with respect to the limited number of available groups. As previously stated, enrollment at the school is of two types. The Associate Classes take a "short" course. Twenty of these men run the problem every month. Using these groups would have taken much too long. The other group, called "Career Classes",

take the "long" course, so scheduled that 100 men run through the problem once a year in December. Even this group of 100, if broken into groups of five men each, could provide, assuming zero mortality, only ten groups under each condition.

We were able to observe the problem informally in October, and to run a very small pilot study in November, before carrying out the experiment on the large group in December. The decision to run the study involved a calculated risk, since, with the small number of groups involved, and the number of uncontrolled factors which might affect the outcome, it was unlikely that we would obtain differences for which we could claim high statistical significance.* Arguing on the positive side was the sheer importance of the problem and the need to determine the feasibility of such studies in attacking some of the questions posed by the guidelines.

THE EXPERIMENT

Purpose: This experiment was to be a small pilot test of the use of simulated situations in the study of the effects of communications media on the effectiveness of staff functioning.

Setting: The experiment was conducted in three large rooms at the Officers' Department of the U.S. Army Signal School at Fort Monmouth, New Jersey. The 100 man career officer class was divided into twenty groups of five men each, using the same groupingswhich had been used for previous class work. The twenty groups were divided into experimental conditions as follows:

(1) Telephone Groups. Each member of these groups was seated at an individual table and permitted to communicate with other members of his group via a field telephone network, operated through SB-22 switchboards.

*The term "statistically significant" refers to the probability that the difference did not arise because of chance inequalities between the samples (groups) or, to state it another way, the probability that the samples (groups) actually represent different classes of people with respect to the thing we are measuring. The difference is said to be significant at the 5% level if there are 95 chances in 100 that it did not arise by chance — at the 1% level where 99 chances out of 100 exist. When it falls short of the 5% level we traditionally say it is "non-significant".

The switchboard, along with associated recording equipment, was located in an adjacent room.

(2) Electrical Message Groups. Members of these groups were seated at individual tables and permitted to communicate with each other only via written Joint Messageforms (DD 173) which were passed through a simulated electrical message network.

(3) Conference Groups. Each such group was seated around a table and free interchange was permitted within each group.

Each individual was furnished a full set of instructional material and members of the two experimental groups were also furnished with individual situational overlays. One situational overlay was provided for each conference group. No inter-group contact was permitted for any of the groups. In order to prevent possible inadvertent overhearing, masking music was played at a reasonable volume throughout the experiment.

The Problem

All groups solved the same Practical Exercise, "Communications for the Infantry Division in Retrograde", which was prepared by the Signal School Staff. It requires the development of detailed plans for the communications to support a rear and delaying action in the Yugoslavian mountains. Complete information on the tactical situation is presented to the groups in advance. This includes disposition of the units involved, their strengths and supply resources, and disposition of the enemy forces. Divisional Operations Plans for the mission, assigned by Corps, are presented in detail, including the G2 estimate of the situation. There are five requirements placed on the Signal Staff:

(1) A Radio Relay,

(2) A Systems Diagram, outlining the disposition of equipment to support the three phases of the retrograde movement,

(3) A Radio Concept, outlining the proposed functioning of communications during these three phases,

(4) A Deception Plan, and

(5) An Operational Order needed to set the plans in motion.

After the Division Signal Officer (DSO) is selected, he assigns the men in his group as Assistant Division Signal Officer (ADSO), Radio Officer (R), Radio Relay Officer (R/R), and Wire Officer (W). The DSO presents his preliminary concept of the solution, and each officer is assigned his respective portion of the problem. Each man is to carry out his task with appropriate coordination with other members of the staff, as necessitated by the division of labor, and under the direction of the DSO.

Army Personnel

All officers working the experiment were nearing the end of a nine month course in communications. Their ranks were lieutenant and captain; their command and communications experience was highly variable. Fifteen officers in the course were from Allied Armies; no more than one Allied officer was assigned to any group. Otherwise, we were given to understand that groups were randomly assigned with respect to rank and experience.

There were four phone, four electrical, and two conference groups on each day of the experiment. One phone and one electrical group failed to turn in their paper requirements.

Procedure

1. General

All officers had been given the problem materials prior to the experimental period. However, the specific requirements for the signal staff were not given until just before the experiment. Officers, therefore, were familiar with the general situation and operation plan, but did not have an opportunity to work on their particular assignments beforehand. Each day, the whole class was first brought together. The instructor gave his regular introduction and instructions about the problem, and assigned DSO's before the experimenter was introduced. The experimenter then read a statement about the purpose of the experiment and about general procedure (see Appendix A) before the groups for the three conditions separated for their specific instructions.

The DSO for each group was charged with the responsibility of formulating a preliminary plan, and relaying this to his men by the given medium. Each man in the group was then assigned his specific mission.

A copy of the instructions given to each group is included in Appendix A. Each officer had with him the teaching materials for the P.E. and was permitted to use any of his customary references. Officers and groups having the same staff assignment were spatially separated as much as possible, and in no cases were seated adjacently.

2. Conference Groups

Although in a round table situation, members of the conference groups were requested to limit their conversation to necessary coordination. All conversation was recorded, with each speaker identifying his own staff position and that of the person whom he was addressing. This enabled us to identify, at a later time, speakers and addressees from the tape. A situational map was provided for each group.

3. Simulated Electrical Groups

Each desk was provided with a situational map and a supply of Joint Messageforms color coded to groups. When an officer wished to send a message, he wrote it on a Joint Messageform and hand carried it to the message center. The message center consisted of several typists, a time clock, and an IN and OUT basket. The officer turned in his message by time stamping the form and dropping it into the IN basket. The typist working for his group would pick up the forms from the IN basket in the order in which they were received and type them, placing typed copy in the OUT basket. Typed messages were immediately picked up by a runner and delivered. This procedure gave us a record of the time delay within the message center.

The first message for each group was a multiple-addressed message from the DSO to all other members of the group. This was the DSO's preliminary conception of the signal plan. Subsequently, all messages were single addressed, though senders could specify that an Information Copy should be sent to one other officer of the staff. The original message form and one typed copy were retained at the message center. The addressee's copy, the Information Copy (if there was to be one), and the sender's comeback copy were delivered in that order. Under this condition, two message center manning patterns were studied, one having twice the staff of the first. In the first, hereinafter referred to as E-I, two typists and one runner were used. In the second (E-II), four typists and two runners.

The original plan called for three experimental conditions: telephone, electrical, and conference groups, with greater emphasis on the telephone and electrical groups. An initial evaluation of the simulated electrical message center suggested that an increase in capacity of the message center was necessary, resulting in an unequal distribution of groups per condition.

4. Phone

Phones were color coded to identify the group and were connected into a switchboard attended by an operator. An officer wishing to make a call would ring the operator, identify himself for purposes of the recording, and be connected with the desired member of his group. The operator monitored calls, connected the recorder, made sure identification was given, and disconnected when the speakers rang off.

The first call for each group was a conference call in which the DSO outlined his preliminary plan of solution. After that, any officer could call any other member of his own group, but no more than two people from a given group could be on the line at the same time. Each officer had available a situational map.

Rating Solutions

The five requirements were rated separately, allowing 10 points for each of five parts, thus yielding a perfect score of 50. This rating was carried out by two instructors in the Signal School familiar with the problem requirements, working in collaboration with a member of The Franklin Institute staff who had run the problem and was skilled in rating scale methodology. A set of explicit scoring criteria was prepared in advance to insure comparable standards being applied in the ratings of all 18 groups.

RESULTS

Results are presented in Table 1. No significant differences were found between any of the media. This indicates that media differences, if they exist, are not sufficiently important to affect the adequacy of solution on a simulated field problem of this type.

Table 1

SOLUTION ADEQUACY RATINGS

Group	Telephone	Electrical I	Electrical II	Conference
	25	23	15	21
	23	25	26	19
Rating	35	21	25	16
	38	*	29	23
	31			
	15			
	15			
	*			
$\bar{X}$ Average	26.0	23.0	23.8	19.8

* = missing data

Comparison of the two electrical conditions indicates no difference associated with the changed capacity of the message center in terms of adequacy of solution.

Table 2

SUMMARY OF ELECTRICAL MESSAGE CENTER LOADINGS

Condition	Total Messages Written	Average Time in M. C.	Number Messages Delivered	Number Messages Undelivered at end	Average Time in M. C.
I	*30	36.0	12	18	101.9
	24	25.1	18	6	74.0
	18	34.9	9	9	126.4
	13	25.5	10	3	55.3
Average	21.3	29.6	12.3	9	95.5
II	6	11.7	6	0	0
	20	6.6	19	1	14.0
	11	10.9	11	0	0
	9	10.8	9	0	0
Average	11.5	9.2	11.3	0.3	14.0

*Group that did not turn in requirements

Table 2 presents a summary of electrical message center operations for the two conditions of this experiment. For E-I there were, on the average, twice as many messages written (21.25) as for E-II (11.50). Average message handling time was about three times as long for E-I (29.6 minutes) as for E-II (9.2 minutes). Because of the large number of messages and the long handling time, there were an average of 9 messages per group left undelivered at the end of the problem period for E-I. There was only one undelivered message left for E-II. This means that although E-I wrote twice as many messages as E-II, it had the same number of messages delivered. The first question to ask, though it is unanswerable at this time, is what led E-I to write so many more messages? The second question, and the most interesting finding with respect to the relation between communication and decision processes, is: Despite the fact that only half the messages written were actually delivered, how is it that this group achieved essentially the same average Adequacy Score (23.0) as E-II (23.8), where practically all messages were actually delivered? Figure 1, where number of completed communications (delivered

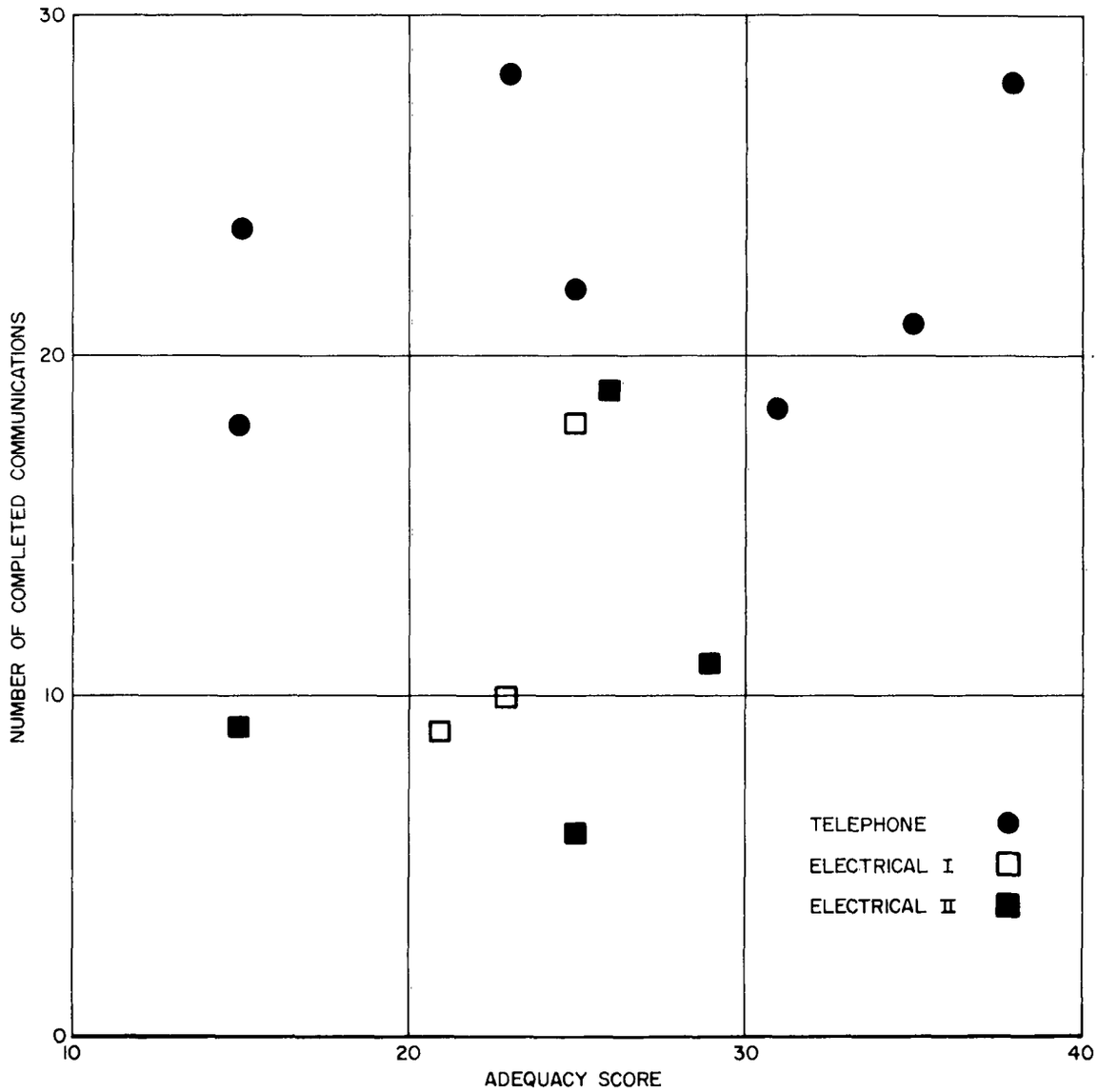

FIG. I. NUMBER OF COMPLETED COMMUNICATIONS VERSUS ADEQUACY SCORE

messages for electrical groups, number of calls for telephone groups) is plotted against Adequacy Scores, confirmed this lack of relation.

A very interesting point is that the raters went over the undelivered messages for E-I and found that the content of these would have added a total of only four points (over all four groups) to the Adequacy Scores. We can conclude, therefore, that the scores for E-I would NOT have been significantly higher even if the message center had been 100 percent efficient.

Our present data does not allow for a complete explanation of these findings. One hypothesis suggested by an examination of the undelivered messages is that these gave rise to further inquiries concerning the status of the replies, thus developing an increasing backlog of undelivered messages.

From the recordings of the telephone and conference groups, and the copies of electrical messages, it would be possible to extract further information relating to the present results. A content analysis of these records would be a long and expensive undertaking, requiring typed transcriptions of the recorded conversations. With our present limited effort on this experiment, we did not feel justified in undertaking such detailed and systematic analysis of the content of the communications.

Our initial observation of the large difference in number of communications between E-I and E-II led us to look for differences between the personnel that might have transcended the differences in experimental conditions and media.

There are several possible sources of such personnel differences between the two groups.

1. Overall Officer Differences

   a) Higher class standing

   b) More communication experience

   c) More command experience

2. Differences in DSO's Alone

   a) Higher class standing

   b) More communication experience

   c) More command experience

These above variables were each correlated with adequacy scores. Analysis of covariance across media, removing the effects of each of these variables upon adequacy scores, all proved nonsignificant, hence, they had no effect upon Adequacy Scores.

The flow of communications is another matter of some interest. This can best be seen in terms of the From-To Matrix as in Table 3.

Table 3

MATRIX OF RANKED SUM OF CONTACTS FOR ALL GROUPS

		From				
		DSO	ADSO	Radio	Rad. Relay	Wire
To	DSO	*	2	8	5	7
	ADSO	1	*	16.5	14.5	11.5
	Radio	6	13	*	20	18.5
	Rad. Rel.	3	11.5	16.5	*	9
	Wire	4	10	18.5	14.5	*

This kind of matrix is produced by placing each separate communication in the appropriate cell, summing the communications in each cell, and then rank-ordering these 20 sums. Table 3 shows ranked sums of all groups. We did not find any appreciable differences in the pattern between conditions. A statistical test (Kendall's "W") showed that the amount of agreement among all groups on this ranking was significant.

The important finding in Table 3 is that it shows that the overwhelmingly greatest number of communications were to and from the DSO. As a matterof fact, the eight cells involving communications with the DSO account for ranks 1 to 8 in the matrix. It was this finding that led us to examine the DSO's class standing, communication and command experience separately from the rest of the group in its relation to Adequacy Score. There is no immediate explanation of this finding in our present experiment, but it is of inestimable importance for further understanding of group communication processes since it implies that command linkage is of paramount importance in the solution of tactical problems.

SUMMARY AND DISCUSSION

The major purpose of this experiment was to perform a test of the utility of simulated situations for the study of the effects of communications media on the effectiveness of staff functioning. Four different communications media (telephone, two types of simulated electrical, and face-to-face communications) were studied. The criterion measure of staff functioning effectiveness was a rated adequacy score of the goodness of solutions to a standard Signal Corps School Practical Exercise.

The experiment demonstrated that simulated situations can be effectively employed for studying communication systems. A number of specific findings are also worthy of note. First, no statistically significant differences were found between adequacy scores for the different media of communication. This lack of difference between media, although not conclusive proof that the media are, in fact, equivalent - particularly in view of the small number of cases - is nevertheless of great interest. Intuitively, one might expect just

the opposite, for the telephone is characterized by the transmission of voice inflection and immediate feed back for query and clarification and, for that matter, by greater bandwidth and thus higher information transfer capability in general. These superior information transfer characteristics should then lend to higher adequacy scores. Quite possibly, the explanation lies in the view that the effectiveness of staff functioning, as measured by solution adequacy, is not simply a function of information transfer. Indeed, the hard copy features of written communication, allowing as they do both the writer and the reader to re-read and study not only a single communication but all previous communications in the sequence, may well be a major factor in effective staff functioning. This factor might then act to cancel the value of information transfer per se. As a matter of fact, we may further suggest that the value of hard copy is related to problem complexity and that in extremely complex problems - say those requiring days rather than hours for solution - written media would prove superior to spoken, despite the increased information transfer capability of the latter. Survey and questionnaire data* developed under other aspects of this program tend to support this view. For example, 79 percent of the staff officers queried favored communication media which provided a hard copy as opposed to media which didn't.

Also of interest are the results of a preference ranking of communication media which revealed no significant favoring of electrical message over telephone. At first glance this essential equivalence of electrical message and telephone seems to be at variance with the overwhelming preference for media which provide hard copy. It is however quite possible that the relatively large delays associated with the existing procedural mechanisms for written communication tend to offset the advantages of the hard copy. It will be recalled that the present experiment virtually eliminated these time differences.

*For a fuller discussion of these data see Mayfield, C.E.M., People Organizations and Communications, An Operations Research Study of Army Communications, General Communications Questionnaire Data, Franklin Institute Report I-A2313-3, May, 1961.

Another result of interest was the failure of the undelivered electrical messages of group E-I to significantly influence the group's adequacy scores. While this result may be related to the relative simplicity of the problem, it may also be indicative of a general tendency to overcommunicate. Another possible contributing factor suggested by a preliminary content analysis of the traffic is the tendency for delays to produce additional messages inquiring about the status of prior messages, thus generating an ever-increasing backlog. In summary, as voice - particularly secure voice - facilities are more costly and technologically complex than teletypewriter facilities, they can only be justified if they lead to significantly improved staff functioning. Thus, it is of extreme practical importance to validate the tentative results of this pilot experiment by:

(1) additional experimentation employing varied staff problems of increased complexity and considerably larger numbers of staff groups; and

(2) by actual field tests in operating installations.

IMPLICATIONS FOR FUTURE RESEARCH

The findings of the present study were not meant to be directly applied to the solution of operating problems. Rather, they serve to:

(1) demonstrate the utility of simulated situations for the study of the effects of communications media on the effectiveness of staff functions;

(2) indicate the direction of future research by serving as a guide to the uncovering of significant underlying variables in the military communication process.

In subsequent pages, we shall discuss some of these underlying variables and their possible interrelationships in some detail. Finally, based upon the findings of this investigation, we shall briefly outline a program designed to provide definitive answers to the important questions under consideration.

Types of Variables

Let us address ourselves to a question from the project guidelines which we posed earlier in this report, "What is the contribution of effective communications to effective staff functioning?" The question here is to find the relationships between two complex sets of variables: communication variables on the one hand, and staff function variables on the other. Stated differently, we would like to know how to modify communications practices to effect improvement in staff work.

In addition to communication and staff function variables, there are variables in the context, such as personnel, type of problem, and general "situation and terrain" variables that affect the relations in which we are primarily interested. Studying human behavior is never like the classic model of experimentation where one mixes two chemical compounds and very quickly discovers whether it explodes or not. Rather, it is necessary to study several variables in "concomitant variation" to discover the interactions between them.

For purposes of the present discussion, we will not deal to any great extent with such interactions between variables. Some of these will, of course, be obvious, such as the fact that the variation in kinds of communication media have variations in speed of communication built into them. Probably these interactions will be the most significant findings of further work along these lines; however, prejudgment of them is liable to be misleading. The interesting interactions will arise in the course of analyzing the data. An example of this kind of discovery is our finding that the electrical groups did not differ in quality of solution, despite the fact that only half of the initiated messages were actually delivered in E-I. Experience in research on complex human situations has shown that the best approach is to isolate and manipulate the obvious basic variables. Further work will grow out of the questions raised by results as they accumulate.

A. Communication Variables

Let us first examine the phenomena under the heading of communication variables, starting off with the most obvious: the kind, the speed, and the amount of communication. Our present experiment was directed at studying the effects of varying the kind of communication. The question was whether different media of communications have built into them, either inherently, or by long established custom and procedure, some factors that will affect staff functioning. One such factor might be the presence or absence of "communication residue", a "hard copy", that can be used for later reference. The present TELECON facility (Teletypewriter Conference) may be seen as combining the hard copy feature of written and electrical means with the speed and immediate feedback features of telephone and face-to-face communication. Another factor in media differences may be the availability of "non-content" cues. In telephone communication, there are voice inflections, and in face-to-face conversation facial expression cues in addition, that may affect the process. Knowledge of whether one is "getting it across" can be very important to a communicator. The massive research effort on speech compression has had to consider this kind of question. It might be noted that in conversations with officers about the general problems of communications, several mentioned that they avoided present secure telephone facilities because of the "unnatural" quality of the voice reproduction. They seemed to feel that the unpleasantness this generated interfered with efficient communication.

In discussions of communications processes, it is almost always assumed - unquestioningly - that the more communication, and the faster it flows, the better. Our finding that half of the initiated messages can remain undelivered without affecting the quality of solution, leads us to feel that this assumption should be questioned. We would ask rather, where, when, and how, does speed and amount of communication affect staff functioning, and what are the optimum speeds and amounts of communication for different problem situations?

Under the heading of "kind of communication", we would raise another question. Communication SOP's make much of "brevity", "clarity", and format requirements. Also, anti-cliché campaigns are frequent and widespread. We would ask what is brief - or clear - with respect to different kinds of communication content and different kinds of communicators? There is a prejudice in our culture - based mainly on aesthetic considerations - against the use of clichés; but, in many cases, might not the use of a cliché be more effective in transmitting the desired meaning than some awkward circumlocation produced to avoid the use of that cliché? The purpose of communication is to transfer what is in the mind of the sender to the mind of the receiver. What factors in the communication process facilitate this transferral? We would like to investigate the factors in the encoding and decoding processes that make for the most efficient transmission of meaning.

Taking our present experiment as a model, further work would, to begin with, attempt to keep problem and personnel variables as constant as possible, while varying communication factors singly. Speed of communication, for example, could be varied in experimental procedures and the effect of each variable, singly and in interaction with others, on staff functioning could be ascertained. Given such information, new communication procedures and systems could be evaluated with respect to resulting effects on functional criteria.

Communication Patterns

Another whole area of communication variables is that involved in patterns of communication; who talks to whom, when, how, and why? Questions about communication patterns are particularly pertinent to an organization with so much emphasis on "channels" as the Army. Review and release procedures also place a variety of restrictions on free flow of communications.

In Figure 2 are shown three possible types of communication networks. In the present experiment, the network was like that of Figure 2a,

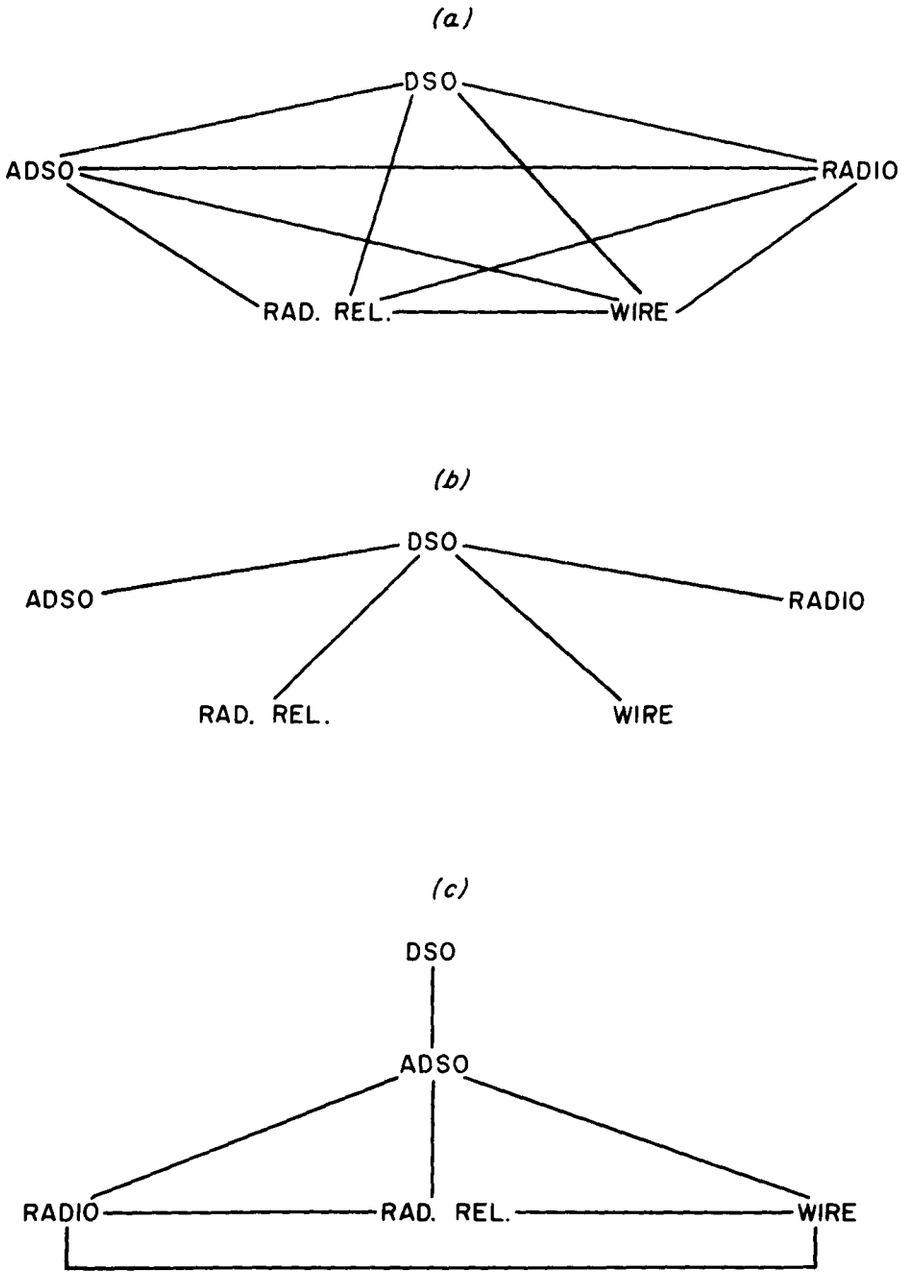

FIG. 2. THREE TYPES OF POSSIBLE NETWORK IN FIVE MAN GROUPS

where everyone within a group could be connected to everyone else in the group. The only restriction was that in the telephone groups only two people could be connected at any one time. From our finding that most communication was to and from the DSO, together with the finding that having only half of the initiated messages not delivered in the E-I electrical groups did not affect quality of solution, we would ask whether the pattern in Figure 2b, where everyone can talk to the DSO but not to each other would have produced a change in the average Adequacy Score. If it did not, and the results generalized to other situations and problems, it might allow for a substantial saving in equipment, manpower, and time in constructing real communications networks. On the other hand, what would the effect be of a network like that in Figure 2c, where all officers at a given level are interconnected, but their communication must be channeled through some point before going up to the next level? This is analogous to the present staff, and command, structures where flow of communication is through a branching tree, coordination being normally at a given level, and other flow "going through channels". Other variations of communication patterning in real and proposed systems could be studied in this kind of experimental situation.

B. Staff Function Variables

Analysis of Staff Functioning

So far, we have spoken of staff functioning as though it were a unitary dependent variable. This was for purposes of exposition and does not imply that we believe that it is an uncomplicated, unanalyzable phenomenon. Without doubt, staff functioning can be broken up into many aspects, each of which may be affected differently by differences in communications and contextual variables. Methodologically, however, analysis would be more difficult. First of all, very often we do not know what to look for in a gross dependent variable when studying the effects of experimental manipulation. In behavioral research, one usually starts off with a loosely defined dependent variable, such as "effective staff functioning", with its subjective and evaluative overtones, and only experience permits a more

objective specification of factors that are related to independent variables. Secondly, and not unrelated to the first, is the lack of complete agreement among authorities - Army officers themselves - as to what, exactly, effective staff functioning involves. In studying these phenomena, we would want to use officer personnel as subjects. This creates its own difficulty because factoring out the effects of subjects' preconceptions about experimental variables is always a difficult task. This is particularly true because subjects usually are sincerely cooperative, and the effects of their preconceptions occur without their awareness.

Attitudinal Variables

For a first suggestion about breaking down the variables that go to make up effective staff function, we would consider a distinction that has become accepted rather widely by researchers in small groups - that between task oriented and attitudinal aspects of group functioning. Task oriented variables are those closely tied to the solution of the problem confronting the group, such as supplying the needed background information, and the number and kind of suggested solutions. Attitudinal variables refer to those variables that affect the establishment and maintenance of a social group. Groups are composed of individuals, and group functioning must supply certain individual satisfactions, and avoid certain tensions and anxieties. To take an extreme, hypothetical, example, one might devise an extremely efficient set of communications means, procedures, and patterns, but if the use of the system developed great dislike among the users, the quality of staff solutions would not be optimum. A more realistic case would be the disruption of a conference by two men who just "rubbed each other the wrong way". A similar problem was raised, by implication, in an article by Captain B. T. Bashore in the MILITARY REVIEW*. Captain Bashore discussed what he called the "inflation of rank" in staff and command relationships taking place in the realignment of echelons in tactical units. In the classical tactical structure, communication is normally between people separated by one or at the most two ranks: lieutenants at platoon level interact mainly

*Bashore, Captain B. T., BA-CORPS Military Review, 1961, XLI, No. 1, pps. 24-28.

with their company commander, a captain, and he in turn with the battalion commander and staff, normally at the major or lieutenant colonel rank, and so on up. There is a slow graduation of rank, age, and experience in this configuration that would seem to make for easy communication about matters that are known largely in common by the communicating parties. With the new organizational configurations, it is possible that frequent communication might be required between, say, a captain at company level and a colonel at brigade level. The large gap in status, age, and experience between these two, the colonel being perhaps many years away from the time he had to deal with company level problems, may very well make communication difficult. The captain and the colonel would have less knowledge in common, and the scope of the context in which each makes decisions would probably be harder to bridge in communicating their needs and desires.

In studying staff functioning, an attempt would be made to keep personality variables controlled, and start working perhaps with the "satisfaction" of the participants as an attitudinal variable. This would be simply a matter of ascertaining if variations in the communication variables produced differences in the member's willingness or desire to come back and work under those conditions again. Since staffs are relatively long lived organizations, manipulation of procedures to optimize such satisfaction is likely, in the long run, to optimize effective functioning.

Efficiency

The above questions are aimed at ascertaining the effect of communication variables on the attitudes of staff members. There is still the question of how communication variables directly influence effective staff functioning, as well as their indirect effect through the attidues of participants. As progress is made in the refinement of measures and definition of effective staff functioning, it should provide us with the information to segregate these two aspects of the problem.

C. Contextual Variables

Personality and Group Functioning

Personality differences, like individual differences in ability and experience, one would like relegated to the status of contextual variables. Such variables for the most part would be controlled or measured mainly to allow the extraction of their effect on the variables of primary interest. For example, our attempt to extract the effect of class standing from the hypothesized relation between communication media and Adequacy Score. Standard operating procedure in research on groups is to measure and control for such individual variation in members as previous research and intuition indicate might be important, and as time, facilities, and methods allow for. Beyond this, assignment of members to groups and conditions is randomized as thoroughly as possible to avoid systematic bias in results caused by such individual variations.

Task Variables

There is another set of contextual variables that appear to be extremely important, not only in themselves but because of the high probability of interaction with the communication and staff functioning variables. These are the variables involved in the type of problem presented to the group. Our conclusions about the difficulties we found in achieving reliable differences on the experimental variables in the present experiment (see discussion section, above) are illustrative of the variables in problems themselves that have direct influence on the sought-for relation between communication and staff functioning.

Such things as the difficulty of problems and stress in the situation (importance of solution, or time pressure) have been shown, in previous research, to affect group functioning in striking ways. Of particular interest is the sequencing (time, size, and nature of communication units) of information and requirements to the members of

a decision making group. Such problems are of particular importance in the kind of large scale command control systems being developed and proposed. There has been much work on the problem of information display design to effect the clearest and fastest possible perception of the incoming information. Less attention has been paid to the problem of devising the optimum division of labor in the information handling and decision making processes involved in such systems. Closely related to this is the question of the communication pattern imposed on the operating group, and how it interacts with the other aspects of the system.

Situation and Terrain Variables

Under contextual variables we mentioned general "situation and terrain" variations. This is the term of miscellany, the necessary evil in any conceptualization of a research area where investigation is only in the preliminary stages. At the moment it comprises the interesting and important variations in HQs that we have noticed in our field work. There are large scale variations in procedure, personnel, mission, and history that gives each functioning HQ its own atmosphere, despite standardization imposed by army regulations. In studying the relation between communication, staff functioning, and contextual variables, one would need to intermittently go into the field for data collection, both to verify results coming out of experimental procedures and to introduce new naturalistic observations into the experimental program. The situation and terrain category of variables is set up to cover the probability that some of these observations will not fit any of our preconceived categories. We envision a program designed to allow mutual feedback between field and laboratory, and to isolate and understand the basic variables in the situation with such a program.

Program for Further Research

In previous sections of this report we have discussed the importance of providing definitive answers to the question of the effects of communications media upon the effectiveness of staff functioning. To

recapitulate, voice communication facilities, particularly secure voice, are considerably more costly in both money and bandwidth than teletypewriter links. Thus, decisions on the extent of voice facilities to be provided in the design of improved communication facilities must be based on a quantitative assessment of the relative costs and advantages of both media. This assessment is a difficult one, obscured as it is by differences due to time lags associated with current procedural mechanisms for written communications, and by the general tendency in the military to equate written with official and oral with informal or unofficial communications.

In our discussions, we have also outlined the relevant underlying variables and illustrated the many considerations which must be met in attacking problems of this character. We now proceed to the development of an outline of an experimental program designed to yield results of quantitative character. Such a program can be envisioned as a three phase effort.

Phase I - School Settings

An experimental program utilizing Army personnel as subjects in an Army school setting. This phase would permit the manipulation or control of the relevant variables in the situation. Experience has indicated that such a program conducted by a properly trained group not only does not interfere with the school curriculum, but actually serves to enhance it. This phase would serve both to refine the experimental technique and to provide "answers" leading to the discard of certain variables - in effect the isolation of the core of the problem.

Phase II - Maneuver Situation

The results of the Phase I effort would require validation in a setting which is both more complex and closer to reality. For this purpose, a maneuver situation would be ideal. The results of this phase would justify subsequent studies in operating headquarters.

Phase III - Operating Headquarters Validation

The final phase would consist of a field test in an operating headquarters. In this phase the communications structure of the headquarters would be manipulated and the effect of this manipulation on staff effectiveness measured. Such validation is the difficult but necessary final "proof". Programs in operating headquarters are of necessity complex and carry with them the risk of possible interference with assigned mission. However, it has been demonstrated* that large scale effective data collection programs can be conducted in operating headquarters with a minimal interference if such programs are both properly designed and executed by suitably trained personnel.

The successive completion of these three phases will yield high payoffs in terms of improved military communications systems.

Approved by:

Joel N. Bloom
Project Engineer

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Director of Laboratories

*In other phases of the program reported upon herein, The Franklin Institute conducted large scale data collection programs in six major U. S. Army Headquarters. Both questionnaire and measurement follow-up techniques were employed to test for disturbance and in no case was any evidence of significant disturbance detected.

A P P E N D I X A

GENERAL INSTRUCTIONS
FACE-TO-FACE GROUP INSTRUCTIONS
SIMULATED ELECTRICAL MESSAGE GROUP INSTRUCTIONS
TELEPHONE GROUP INSTRUCTIONS
DE-BRIEFING INSTRUCTIONS

GENERAL INSTRUCTIONS

We have been assigned by the chief's office to answer some questions important in the planning of the details of the UNICOM system. One of these is about what kind of equipment should be given to the individual staff subscriber. The experiment we're conducting here is designed to get part of the answer.

You will be divided into three types of groups in solving the regular school PE: The infantry division advancing to the rear. SOP prescribes that you are to be divided up to simulate a regular divisional signal staff for this problem. The experiment consists in having one group use only telephone communication in solving the problem, another group will have only a simulated electrical network with which to communicate. The third group will simulate a face to face staff conference. The question to be answered by this procedure is whether these modes of communication produce differences in the effectiveness of staff work. More detailed instructions about procedure will be given to the experimental groups later.

As you can see, the validity of the results depend completely on how well communications are confined to the two modes throughout the whole experiment. Therefore, it is absolutely necessary that all communications about the problem be confined to the prescribed methods for each group. So please, gentlemen, throughout the whole exercise, do not talk about the problem - with anyone - by any but your assigned method of communication. If you have times when you are not working on the problem we still ask that you do not communicate with others. We are providing music for your listening pleasure.

In the pilot study a few weeks ago, people raised the question of artificiality in the situation. I had pointed out that in one way, the use of phone and electrical communications was highly realistic, in that in a real tactical situation, it would be unlikely for the

signal staff to be sitting around the same table to discuss their plans. While the experimental conditions do introduce other artifacts, we are aware of these and have taken steps to bring them under either experimental or statistical control.

Please save your questions until your group has received more detailed instructions.

FACE-TO-FACE GROUP INSTRUCTIONS

DSO's will be appointed, after which you will find your tables. Each table will carry a large card with the group designation on it. Ignore the tables having individual place cards.

On each table there will be a situational map. If necessary, each of you will be permitted to complete one overlay for the DSO. Sign your position to your overlay. It is important that any discussion of the problem be confined strictly to your own group.

At the beginning of the problem, the DSO will outline his plan. Do not ask questions at this point. You will then function as his staff in solving the problem. Remember, each man will function as a staff officer in his own specialty. You will, of course, be allowed to use any of your usual references.

We want to emphasize again that there is to be no verbal communication with persons outside of your own group; this includes both members of other groups, and instructors (aside from the formal instructions he gives after the first hour). This applies both during the running of the problem and during coffee breaks. It is also of the utmost importance that only one person talk at a time. This is because the entire exercise will be recorded. For the same reason, each speaker should identify himself by stating his position before he begins speaking.

When you have your final solution to the problem, and are fully satisfied with it, the DSO should himself carry it to the typist for time stamping.

SIMULATED ELECTRICAL MESSAGE GROUPS INSTRUCTIONS

Assigned DSO's will give you your staff assignment. After you have received this assignment, find your assigned table. Each group will be assigned a color, and your table will be identifiable by that color and the appropriate staff position written on a place card at each table.

On each table there will be a situational map, and a pad of joint message forms printed on the appropriate color paper. You will of course be allowed to use any of your usual references.

The DSO will be allowed one multiple addressed message at the start to outline his general plan to his staff. This will be the first message sent out within each group. After that all messages will be single addressed, by staff position, and can be sent to anybody else on your committee. You are allowed any number of messages you feel necessary. You also are allowed to send one overlay to the DSO. Identify your overlay in the from-to manner, and give it to the messenger for delivery.

Remember, each man will act as a staff officer in his own speciality. You are to write your messages on the joint message forms (we tell them which parts can be ignored) and hand carry it to the typist. She will type it and it will be delivered by runner and a come-back copy returned to you.

We want to emphasize again that there is to be no verbal communication with anyone; this includes members of your own committee, members of other committees, and instructors (aside from the formal instructions he gives after the first hour). This applies both during the running of the problem and during coffee breaks.

TELEPHONE GROUP INSTRUCTIONS

Appointed DSO's will give you your staff assignment. After you have received your assignment, find your table. Your place will be identified by a white* place card - with the appropriate committee number and staff assignment written on it.

On each table will be a situational map and a phone. You will be allowed to use any of your usual references.

You will be allowed one conference call at the beginning of the problem. In this, the DSO will give his outline of a plan. Do not ask questions at this point. After the DSO has outlined his plan and the conference call is completed, you will be allowed any number of calls to any other individuals on your committee that you desire. Just ring the phone, when it is answered by the operator, say who you are - by staff position - and say whom you want to be connected with. When calls are completed - ring off.

You will be allowed to send one overlay to the DSO. Remember, each man will function as a staff officer in his own specialty. Identify your overlay in the from-to manner, and give it to the messenger who will be carrying messages for the TWX group.

We want to emphasize again that there is to be no verbal communication with anyone; other than a member of your own group via your assigned medium. This includes members of other committees, and instructors (aside from the formal instructions he gives after the first hour). This applies both during the running of the problem and during coffee breaks (talk about the weather, the state of the nation, or anything - but not about the infantry division in retrograde movement).

When you have your final solution to the problem, and are fully satisfied with it, the DSO should himself carry it to the typist for time stamping.

*Phone groups were also color-coded and the instructions amended by verbal announcement.

DE-BRIEFING INSTRUCTIONS

Gentlemen, please accept our very sincere thanks for your splendid cooperation during this experiment. We know that at times it was trying and we appreciate your patience. May we ask one more thing of you? On Friday this experiment will be repeated on the group meeting then. It is most important that you do not discuss this problem with anyone in that group; to do so could largely invalidate the experiment, so please keep your observations upon the problem confined to your own group until Friday morning. Thank you.

AD ______ Accession No. ______

The Franklin Institute, Philadelphia 3, Pa.

EXPERIMENT COMMAD: A PILOT STUDY ON THE RELATION OF COMMUNICATION MEDIA TO STAFF DECISION MAKING - A. E. Horowitz, S. D. Benson, E. P. Buckley

Interim Report No. 2 of An Operations Research Study of Army Communications, 25 pp-Illus-Graphs, Signal Corps Contract DA-36-039-SC78332, Unclassified Report

This report, one of a series under The Franklin Institute's Operations Research Study of Army Communications, deals with a pilot experiment designed to test the utility of simulated situations for the study of the effects of communications media on the effectiveness of staff functioning. Four different communications media (telephone, two types of simulated electrical, and face-to-face communications) were studied. The criterion measure of staff functioning effectiveness was a rated adequacy score of the goodness of solutions to a standard Signal Corps Practical Exercise. Serving as subjects of the pilot experiment were officers completing the Signal Officers' Career Course at the U. S. Army Signal School. The Practical Exercise was one normally given as part of the course of instruction.

The experiment demonstrated that simulated situations can be effectively employed for studying communications systems. No significant differences on the criterion measure were found between media. Although not conclusive, due to the small number of cases, these results give rise to a number of highly

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